TREE HAZARDS:

RECOGNITION

AND

REDUCTION IN RECREATION SITES

by

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INTRODUCTION

WHY READ THIS ARTICLE?

The information in this article is written primarily for the practicing forester or technician who has responsibility for the maintenance and protection of recreation sites, especially campgrounds and picnic areas. Hopefully this information will serve to stimulate greater interest in recreation site and tree hazard recognition and techniques designed to reduce costly tree failure accidents. Secondarily, the probability of expensive legal actions resulting from tree failures involving forest visitors should be lessened.

No attempt has been made to discuss the specific indicators of defect for every tree species in the Rocky Mountain Region. This information is best presented during field training sessions by trained personnel.

WHAT IS A TREE HAZARD?

In this discussion a tree hazard refers to any tree containing a structural defect that upon failure may result in property damage or personal injury. Because of the complex of factors that combine to make a tree hazardous, it is impossible to state the probability of tree failure with certainty. Every tree will eventually fail; however, the timing of the failure will vary with internal and external factors. Knowledge of common defects of each tree species, site characteristics and local weather conditions is essential in evaluating tree hazards. A defective tree is hazardous only when its failure could result in damage to something of value. In recreation areas, we are concerned with structures, forest visitors and their vehicles.

WHAT IS THE RESPONSIBILITY OF LAND MANAGERS REGARDING TREE HAZARDS?

By legal definition, there are three classes of visitors on a tract of land: the invitee, the licensee, and the trespasser. The invitee is of primary concern to public land managers because every person visiting "land held open to the public" belongs in this category. Of the three visitor classes, the invitee commands the greatest legal responsibility. Legally, these categories are falling into disuse. In most cases, courts require landowners to exercise "reasonable care under the circumstances" to prevent harm to visitors.

Responsibility to ensure public safety is roughly proportionate to the degree of development in a given land area. Highly developed sites such as campgrounds or picnic areas incur a greater level of liability than undeveloped areas.

Due to the fact that all trees have some chance of failure, it is impossible to reduce all tree hazards in a forested recreation area. For a land manager to protect himself from liability, it is necessary to use "reasonable care" to protect visitors. In most cases, "reasonable care" implies that areas such as campgrounds have been evaluated for safety hazards by a professional. Therefore, the best protection against liability is a documented program of annual inspections of recreation areas. Hazards should be identified and a professional decision should be made as to appropriate action. A program of documented safety inspections on a regular basis is essential in reducing hazards.

ARE TREE HAZARDS IMPORTANT IN THE ROCKY MOUNTAIN REGION?

Fortunately, damage resulting from tree failures in recreational areas is a rare occurrence. This does not mean that tree failures rarely occur in the Rocky Mountains. In fact, over 750 tree failures were reported for this five state region consisting of Colorado, Kansas, Nebraska, South Dakota and Wyoming during the last 10 years (Table 1). Considering that this figure only includes reported failures, the actual number of tree failures is probably much higher.

Although most of these tree failures resulted in little or no damage, there is always the possibility that an accident will occur. An accident requires both a tree failure and a target. The target may be a recreational structure or vehicle (causing monetary

Table 1 - Number of tree failures by species reported in recreational areas of the Rocky Mountains for the period 1966-1975 [1]

Forest Community	Tree Species	Reported Failures	Totals
Pinyon-Juniper	Pinyon, *Pinus* spp.	12	
	Juniper, *Juniperus* spp.	5	17
Mixed Conifer	Ponderosa pine, *P. ponderosa*	59	
	Lodgepole pine, *P. contorta*	500	
	Douglas-fir, *Pseudotsuga menziesii*	3	
	White fir, *Abies concolor*	2	
	Quaking aspen, *Populus tremuloides*	91	655
Spruce-Fir	Engelmann spruce, *Picea engelmannii*	53	
	Subalpine fir, *A. lasiocarpa*	10	
	Limber; white bark pine, *Pinus spp.*	0	63
Riparian	Cottonwood, *Populus* spp.	19	
	Blue spruce, *Picea pungens*	14	33
			768

[1] Data obtained from Dr. Lee A. Paine, Pacific Southwest Forest and Range Experiment Station, USDA-Forest Service, Berkeley, California.

loss), or a forest visitor (resulting in personal injury). With the increasing popularity of outdoor recreation, the probability of a failing tree striking a target also increases. In the outdoor-conscious Rocky Mountain area, tree hazards merit serious consideration by all land managers.

Tree hazards are important from an economic standpoint also. Usually, the amount of money lost in tort claims far exceeds the cost of safety maintenance. A court decision in Wyoming awarded over $43,000 for the death of a man in a campground. He was struck by a tree with obvious physical defects that failed without unusual weather conditions [1]. With damage awards increasing each year, the relative cost of tree hazard evaluations becomes minimal indeed.

RECOGNITION OF TREE HAZARDS

COMMON TREE DEFECTS THAT MAY INDICATE HAZARD

Trees that may become hazards can be classified into distinct categories. Each category exhibits unique symptoms and each has a given probability for failure. These categories are by no means discrete; a tree may exhibit several types of defects, thus the hazard is increased. The following categories are listed roughly in order of importance.

DEAD TREES - Snags are the most dangerous type of tree defect. Once a tree dies, decay organisms begin weakening tree structure. This deterioration occurs most rapidly in the butt portion and root system where moisture conditions are most favorable for decay. Structural weakening advances with time making older snags a formidable hazard; however, weathered snags can add scenic beauty to a recreation site and also provide valuable wildlife habitat. A dead tree must prove to be a threat before it becomes a hazard (Figure 1).

LEANING TREES - Leaners constitute a threat only when they have resulted from structural damage. Trees that have grown at an angle usually are reinforced by compensatory growth.

[1] Menefee, C. 1973. The legal implications of hazards from tree disease and related factors in recreational areas. IN: Proceedings of the 21st Western International Forest Disease Work Conference, Oct. 1-5, 1973, Estes Park, Colorado, P. 46-54.

Figure 1 - Dead trees are an obvious hazard in high-use areas and should be removed.

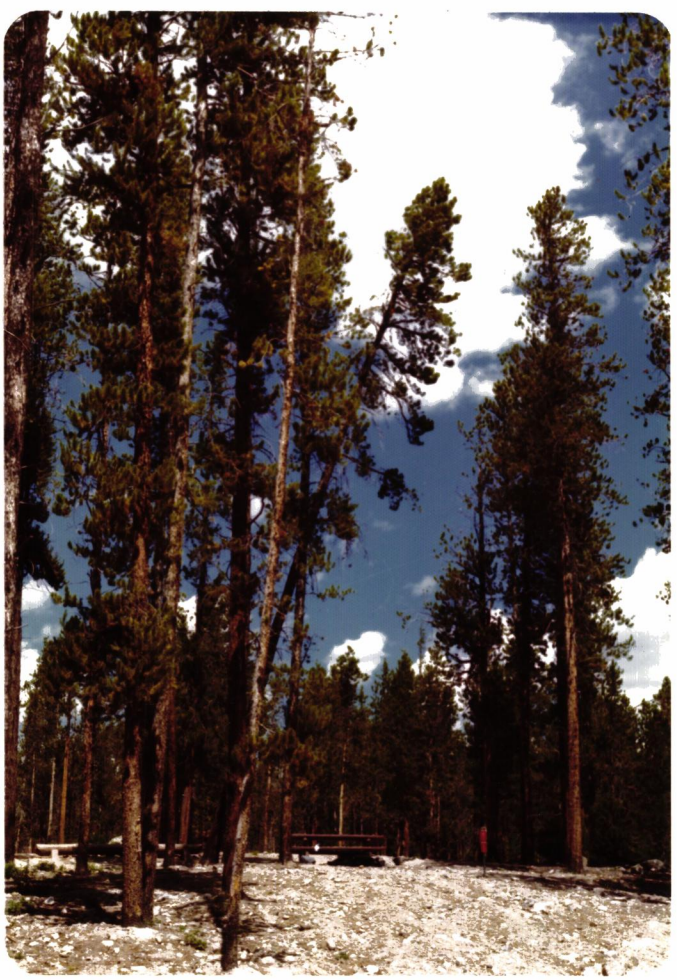


Figure 2 - This leaning tree had a damaged root system and was threatening this picnic site.

Leaning trees are hazardous in direct proportion to their angle of declination. Often these trees become gradually more weakened and a severe wind gust can lead to failure. Leaning trees may have aesthetic value and should only be removed when they threaten visitor safety or recreational structures (Figure 2).

Trees with no apparent defect pose an insidious threat in recreation areas. Many serious structural defects are not readily visible and require detailed inspection. The location of the defect within the tree is an important consideration. Since the greatest number of tree failures in the region was reported for lodgepole pine, the data for that species is presented (Table 2).

ROOT INJURIES - For lodgepole pine 82 percent of tree failures occurred in the root system. The roots function as an anchor, providing the major resistance to windthrow. Any agent causing root damage increases the chance for failure. Wood-rotting fungi destroy wood fiber in the root system greatly reducing strength and resistance to windthrow (Figure 3). Visual symptoms indicating root injury may not be apparent; however, increment cores will usually reveal the presence of root rot. Sporophores (mushrooms or conks) around the base of the tree indicate advanced decay and therefore considerable hazard (Figure 3).

Physical injury to roots can weaken tree structure and may also provide entry courts for rot fungi. Construction activities, vehicular and pedestrian traffic are often responsible for direct injury to roots (Figure 4). The root system may be injured indirectly through soil compaction or fluctuating water tables.

TRUNK INJURIES - Approximately 11 percent of lodgepole pine failures occurred in the trunk. The trunk must support the weight of the entire crown and any structural injury increases the chance for failure. Bole wounds provide entry for wood-rotting fungi that reduce the volume of sound wood and increase the probability of stem breakage. Forked trunks are structurally weaker than single stems. Burls, cankers and scars do not affect stem strength unless complicated by rots (Figure 5).

CROWN DEFECTS - Only 7 percent of lodgepole pine tree failures occurred in the crown region. Because of the smaller dimensions of crown components, damage potential is lower than for other parts of the tree. On very tall trees, however, branches falling from crown height can cause serious injuries. Spike-topped trees are not extremely dangerous unless they are rotten. Forked tops may be hazardous during periods of severe wind stress. Witches'-brooms, such as those caused by dwarf mistletoe or rust fungi, are not dangerous unless quite large or dead.

Table 2 - Location and frequency of tree failures reported for lodgepole pine [1]

LOCATION OF FAILURE	NO. OF FAILURES	PERCENT OF GRAND TOTAL
CROWN		
Limb	58	2
Upper bole	166	5
	224	7
TRUNK		
Lower bole	181	5
Butt	158	6
	339	11
ROOTS	2720	82
TOTAL	3283	100

[1]Data obtained from Dr. Lee A. Paine, USDA-Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California

Figure 3 - Trees weakened by root rot fungi are susceptible to windthrow.

Figure 4 - Injury to tree roots and soil compaction can result from pedestrian traffic along trails.

Figure 5 - Cankers infected with decay fungi indicate substantial structural defect.

Figure 7 - Conks on aspen indicate extensive decay and should be checked with an increment borer.

HAZARDS OF MAJOR FOREST COMMUNITIES

Each forest type possesses unique characteristics and each component tree species has its respective defects. The major forest communities in the Rocky Mountains are presented in terms of their specific hazards.

PINYON-JUNIPER TYPE - There were only 17 reported failures in this timber type during the last 10 years (Table 1). Due to the low physical stature of these trees, the hazard is less than for other forest communities. Juniper is resistant to wood rots and has few other serious defects. Pinyon is affected by rots and other disease and should be inspected on an individual basis. Because of the arid environment of these stands, trees are at a premium; they should be protected when they are an important component of a recreation site.

MIXED-CONIFER TYPE - The majority of reported failures occurred in this forest type (Table 1). Of the 5 tree species composing this type, the pines and quaking aspen accounted for 99 percent of the total failures. Because of the inherent differences in these tree species, they will be discussed separately.

Pines - Areas with predominant pine cover are commonly used for campgrounds and picnic areas. The major difference between lodgepole pine and ponderosa pine is that lodgepole pine has very thin bark, which is easily damaged. Dwarf mistletoe is the major disease of pines in the Rocky Mountains and large witches'-brooms should be removed to eliminate hazard and improve tree vigor. Wood-rotting fungi are common in pines. Indicators of rot include basal fire scars, unusual swellings, swollen or punky knots and ideally, presence of sporophores. Unfortunately, due to the dry climate in this region, most wood-rotting fungi rarely form sporophores. Thus, trees exhibiting suspicious symptoms should be bored to confirm rot and determine the amount of sound wood. The thickness of sound wood in the outer shell determines structural strength in trees with rot defect; the minimum standards for safety are given in Figure 6. Rots must be considered together with other defects. For example, a leaning tree can tolerate less rot defect than an upright one. Root rots are, of course, the most critical and increment cores should be taken in the basal portion of suspect trees. Burls and cankers commonly occur on pines. These defects do not constitute a hazard unless they are so extensive as to weaken stem structure or are complicated by rot.

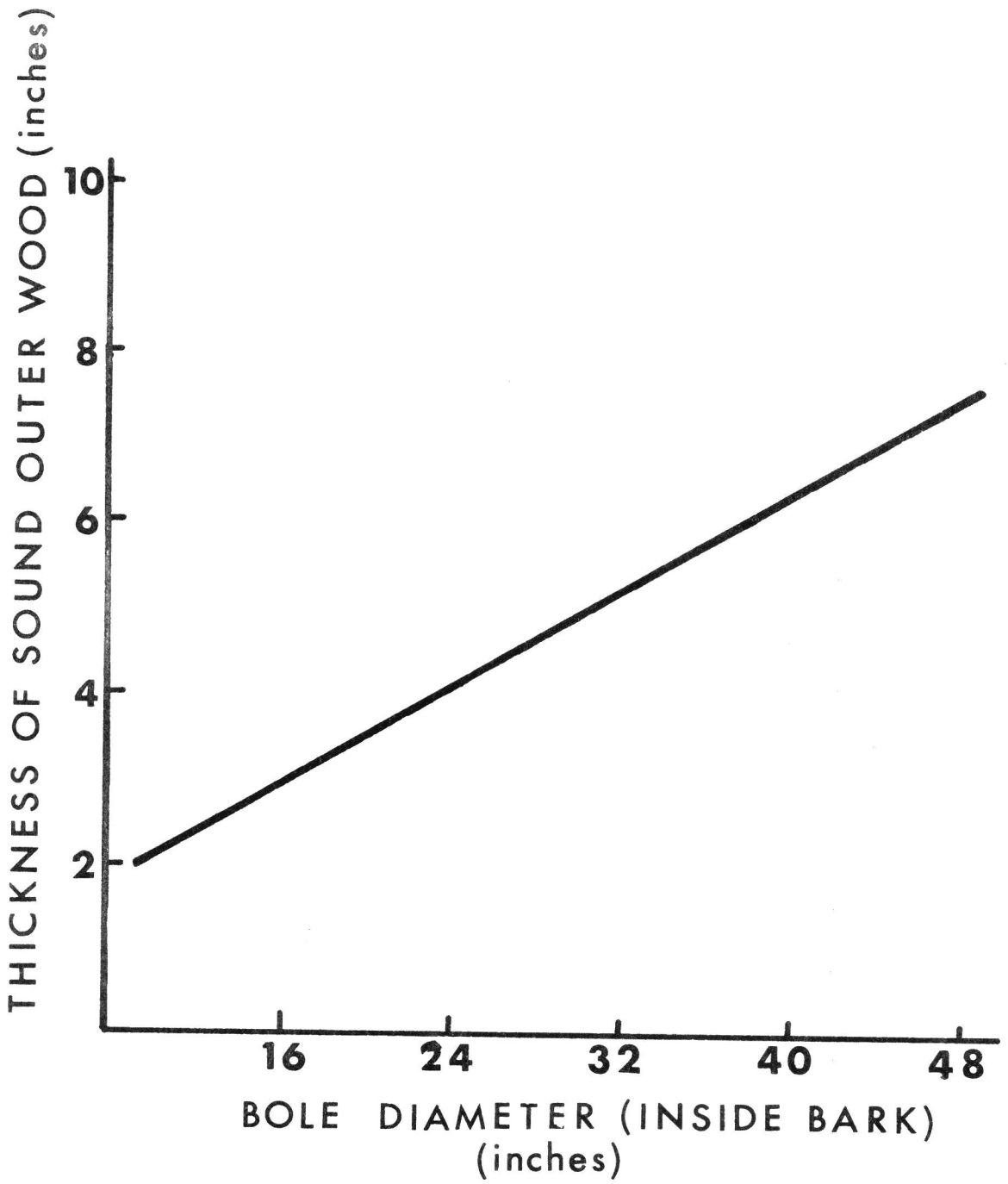


Figure 6 - Thickness of sound wood in outer shell required to maintain 66% of original strength in trees with heart rot (modified from Wagener, 1963).

Aspen - Pure aspen stands usually contain many defective trees (Figure 7). Aspen have fragile bark and are especially susceptible to bole injuries, which often provide entry sites for canker fungi. Cankers do not weaken trees structurally unless they are extensive or are compounded by rots. Increment cores may be necessary to define the amount of defect in this species; however, cores should be taken only when necessary. Other tree species in the mixed conifer type should be evaluated for obvious defects and rots. Root rots should be the principal defects for investigation.

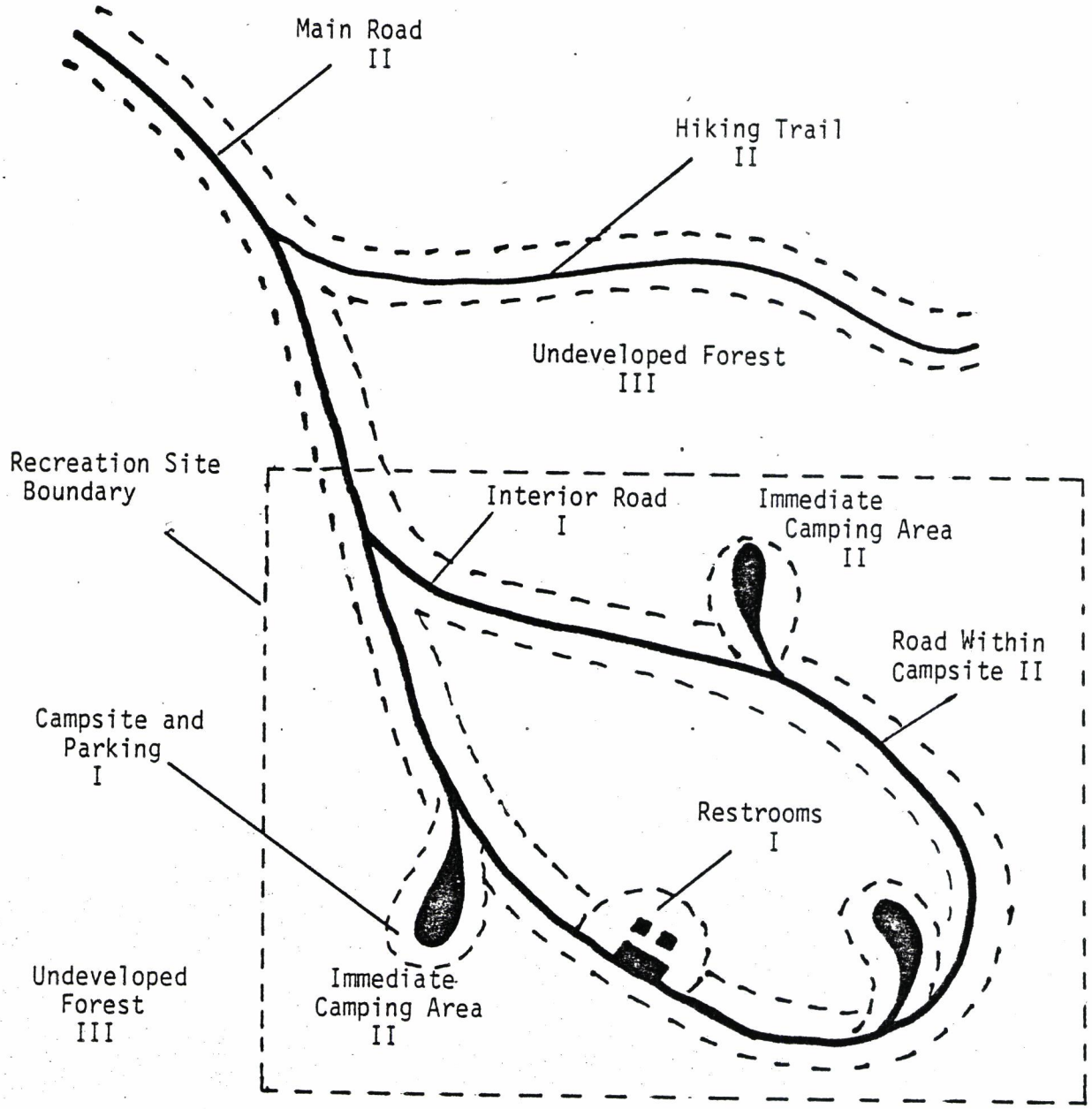
SPRUCE-FIR TYPE - This forest type had the second greatest number of tree failure reports from 1966-1975 (Table 1). Rots commonly occur in large, overmature spruce-fir forests. Subalpine fir is particularly susceptible to wood-rot fungi and the frequency and extent of rot increases markedly with age. Trunk wounds, punky knots, frost cracks, and broken tops often indicate decay in spruce and fir; whereas, burls and cankers do not. Conks, when present, indicate advanced decay. When defect is suspected, increment cores should be taken to confirm the presence of rot. Spruce and fir are not windfirm due to shallow root systems. Therefore, any damage to the roots will increase the probability of windthrow. Rust brooms, unless large, are not of serious concern. Both of these conifers are relatively tolerant of bole damage.

RIPARIAN TYPE - Bottomland forests are favorite recreation sites because of their location near water. Blue spruce and cottonwood are the most common species in this forest type. Blue spruce has basically the same type of defects as Engelmann spruce and should be evaluated similarly. The main defect of cottonwood is large dead or rotten branches. Larger trees are often rotten and the amount of sound wood should be measured on increment cores. Slime flux (foul-smelling and unslightly bleeding from wounds) and wetwood should not be confused with wood-rotting fungi. These indicators are common in hardwoods and usually do not indicate decay. Because of the high water table and coarse soil structure, many river bottom trees are not windfirm.

TREE HAZARD EVALUATION

Basically tree hazard evaluation can be accomplished in three steps: identification, documentation and corrective action.

Identification - Before initiating a tree inspection, the area should be stratified into tree hazard risk zones (Figure 8). Intensity of the inspection should vary directly with the risk



TREE HAZARD RISK ZONES (zone width varies with tree height)

I High Risk - High use areas with concentrations of people, parked vehicles and permanent structures. Highest priority for regular inspections.

II Medium Risk - Intermittent use by people and moving vehicles. Low priority for inspections.

III Low Risk - No vehicles or structures and low visitor use. No inspection required.

Figure 8 - Recreation areas should be divided into hazard risk zones which determine the intensity of evaluation.

level. All trees within falling distance of targets (structures, vehicles or recreationists) should be inspected. Tree height determines width of the hazard zone. The inspection should be concentrated in High Risk Zones (I) because concentrations of people and most structures are found in this area. Medium Risk Zones (II) should be inspected as time allows since the priority is lower. Low Risk Zones (III) incur almost no liability and therefore regular inspections are not required.

Trees must be evaluated individually. Due to differences in site, microclimate and developmental history, trees vary in hazard potential. Defects must be considered in relation to external factors such as prevailing winds, location with respect to other trees, relative vigor and distance and direction to a target.

The purpose of a hazard tree evaluation is not to remove every tree that exhibits defects. Such a policy would greatly reduce the number of trees in an area and perhaps even destroy the aesthetic qualities for which the recreational site was chosen. Removal of one tree affects the entire stand. Stand stability is often reduced and the probability of windthrow increases.

Trees should be inspected in a systematic manner. Begin with the root system and work upwards toward the crown noting all defects. Examine all sides of the tree for rot indicators and take increment cores of suspect trees. Look carefully at the root system. After noting any structural defects, step back and consider aspects of the environment that may influence the hazard and note the proximity to any targets. Assign a risk rating to each tree (high, medium, or low) and decide on the type and priority of corrective action. Most decisions will not be clearcut; if unsure, note the tree location and return later in the day. Constantly try to think of the benefits that a tree is providing as opposed to the hazard that it poses.

Documentation - It is extremely important to document hazardous trees. In order to reduce legal liability, a record is required. Documentation proves that the land manager is aware that hazards exist and that the area has been inspected for these hazards. High-use areas should be evaluated yearly. Inspections just prior to the recreation season are usually best. Summer and fall use areas should be inspected in the spring; whereas, winter use areas should be inspected in the fall. Permanent records should be maintained on each site to provide a case history. Documentation is best accomplished by use of a form that will insure that basic information has been gathered during each evaluation. A recommended form is included in the Appendix.

Corrective Action - This is the final step in the evaluation process. It is also the most expensive and time-consuming but greatly reduces the probability of serious damage, costly cleanup action and tort claims.

Action should be taken as soon as possible after the initial evaluation. Hazard reduction can often be accomplished by means other than tree removal. Pruning dangerous limbs or stimulating tree vigor can alleviate hazard. High-value scenic trees can be reinforced or the defective portion removed. In some instances the target (picnic table, rest rooms) can be moved to a safe distance. Marginally hazardous trees should be recorded on the form and observed over a period of time. If the risk of failure increases, corrective action should be undertaken.

APPENDIX

TREE HAZARD EVALUATION FORM

The enclosed evaluation form provides a standardized method of documenting tree hazards. Hazards are rated as to type of defect, potential target, type of action to be taken, and action priority. If this form is used at regular intervals and filed appropriately, the degree of legal liability will be significantly lessened.

TREE HAZARD EVALUATION FORM

Forest _____

District _____

Recreation Site _____

Submitted By _____

Date _____

Campsite or Picnic Unit No.	Tree Location (Azimuth & Distance from Fixed Objects)	Tree No.	Species	DBH	Type of Defect											Potential Target			Action Recommended				Action Priority				Additional Comments
					Dead Tree	Leaning	Uprooting	Root Rot	Butt Rot	Basal Cavity	Weak Crotch	Limb Defect	Brooms	Mechanical Injury	Other (Explain)	Permanent Structure	Parked Vehicle	People	Fell	Branch Prune	Crown Reduction	Top	High	Medium	Low	Observe	

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